

Psychoacoustic Dither in ADDA 2402

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The Dither method implemented in the ADDA 2402 is based on the principle of Psychoacoustically Optimal Noise Shaping (PNS)¹. In this technical paper a short description of the principle is made.

Basically dither is applied to a digital signal when the word length of the digital data has to be reduced from a higher number of bits to a lower number of bits. The dither signal will reduce the errors and distortion introduced by the requantization process. For instance when a 24 bit digital signal has to be reduced to 16 bit before being recorded on a CD. The requantization process, which can be truncation or rounding inherently, introduces an error signal to the bit-stream since it just cuts off or round the least significant bits. But when an appropriate noise signal is added, the error signal will be ‘assimilated’ in the noise spectrum, thus removing the audibility of the distortion.

A simple form of dither is a noise signal with a white noise power spectrum having a peak value of 2 LSB (± 1 LSB) (Least Significant Bit) related to the LSB’ of the reduced bit resolution as shown in Fig. 1 and Fig. 2

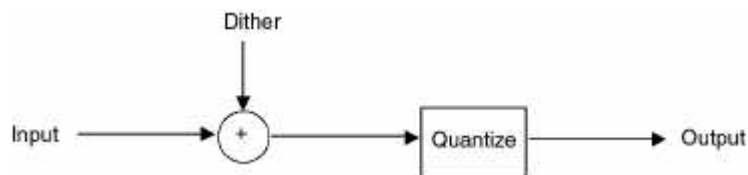


Figure 1, Simple dither principle

The bit format of the digital audio signal will be reduced as shown in Fig.2.

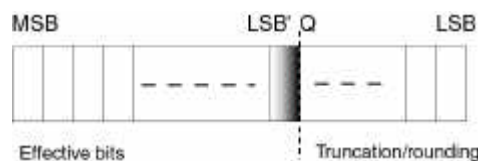


Figure 2, Requantization, using the simple dither principle

The drawback of the white noise dither is that it has an equally distributed power spectrum in the signal frequency range, which makes it quite sensitive to the human ear. Noise shaping techniques are a generally used method to reduce the perceived requantization noise level by feeding the requantization error generated by the truncation of the rounding process back to the input. In order to improve the process a filter can be applied on the feed back signal. The principle is shown in Fig.3.

¹This principle has been published by Robert A. Wannamaker [1].

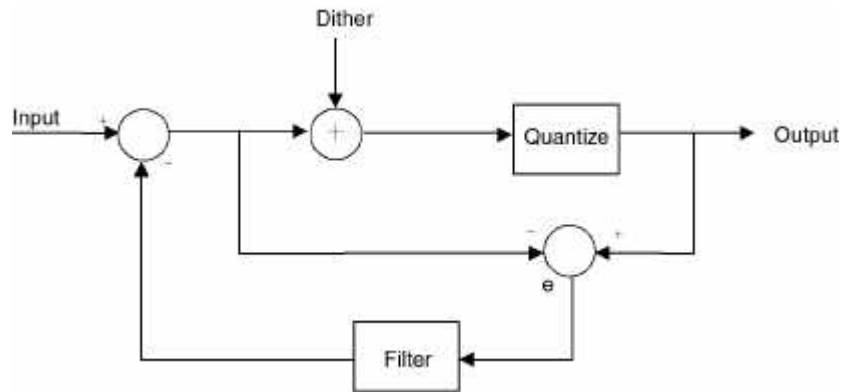


Figure 3, Psychoacoustic dither

The idea of Psychoacoustically Optimal Noise Shaping is to select a filter that reduces the audibility of the output noise spectrum, by ‘moving’ the noise spectrum to frequencies where the sensitivity of the ear is relatively low. Psychoacoustic Dither is based on a feedback filter with a response according to the ears sensitivity as defined by the International Organization of Standardization (ISO). This filter is referred to an E-weighting curve. The curve is shown in Fig. 4.

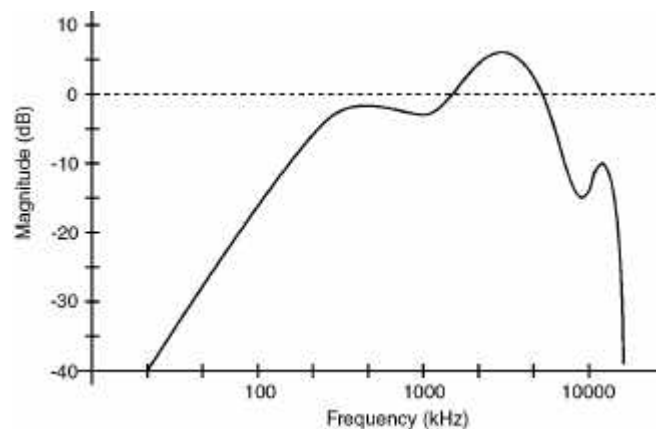


Figure 4, E-weighting curve

The actual implementation of the Noise shaper, and the calculation of the filter coefficients of the E-weighting curve is quite complicated, and outside the scope of this paper. For more information please refer to [1].

References

- [1] R. A. Wannamaker: “Psychoacoustically Optimal Noise Shaping”. J.Audio Eng. Soc., Vol 40, No 7/8, 1992.
- [2] R. A. Wannamaker, S. P Lipshitz, J. Vanderkooy: “Minimally Audible Noise Shaping”. J.Audio Eng. Soc., Vol 39, No 11, pp.836, 1991.
- [3] R. A. Wannamaker, S. P Lipshitz, J. Vanderkooy: “Quantization and Dither: A theoretical Survey”. J.Audio Eng. Soc., Vol 40, No 7, pp.601, 1992.